

What is claimed is:

1 1. A transcoding method of performing conversion between compressed
2 bitstreams having at least syntax elements and video elements corresponding to
3 video data, the transcoding method comprising the steps of:

4 a) decoding a first bitstream compressed according to a first compression
5 method and parsing syntax elements and video elements;

6 b) mapping the parsed syntax elements to syntax elements complying with a
7 target second compression method;

8 c) partially reconstructing video data complying with the first compression
9 method from the parsed video elements;

10 d) requantizing the video data reconstructed in the step c) according to the
11 second compression method; and

12 e) coding the mapped syntax elements and the requantized video data to
13 obtain a bitstream complying with the second compression method.

14 2. The transcoding method of claim 1, wherein the first compression
15 method is a moving picture experts group (MPEG)-1 compression method, the
16 second compression method is a MPEG-4 compression method, and the step b)
17 comprises:

18 b-1) converting a MPEG-1 f_code into a MPEG-4 f_code;

19 b-2) converting a MPEG-1 macroblock (MB) type into a MPEG-4 MB type;

20 b-3) converting a MPEG-1 coded block pattern (CBP) into a MPEG-4 CBP;

21 and

22 b-4) converting a MPEG-1 MQUANT value (a quantization parameter in
23 MPEG-1) into a MPEG-4 DQUANT value (a difference of quantization parameters).

24 3. The transcoding method of claim 2, wherein the step b-1) performs the
25 conversion according to the following equation,

$$\begin{aligned} & \text{vop_f_code_forward} \\ & = \max((\text{forward_f_code} - 1), 1) \end{aligned}$$

where $\max(a, b)$ is an operator of selecting a larger value between "a" and "b".

4. The transcoding method of claim 2, wherein the step b-2) comprises the steps of:

- (i) setting "nomc+coded" as a MPEG-4 "inter" type and setting a motion vector to (0, 0);
- (ii) setting "nomc+coded+q" as a MPEG-4 "inter+q" type and setting a motion vector to (0, 0);
- (iii) setting "mc+not coded" as a MPEG-4 "inter" type, using a motion vector as it is, and setting both "cbpy" and "cbpc" to zero; and
- (iv) setting the value of "code" determining "not coded" in MPEG-4 to 0 such as "cod=0" as many times as skipped MBs.

5. The transcoding method of claim 2, wherein the step b-3) comprises the steps of:

b-3-1) individually coding cbpy according to the following equation,

$$cbpy = (cbp \& 0x3c) \gg 2$$

where "&" indicates an AND operation performed in bit unit, "0x3c" indicates "3c" of a hexadecimal number, and ">>n" indicates an n-bit right shift operation; and

b-3-2) coding cbpc according to the following equation,

$$cbpc = (cbp \& 0x03) \gg 2,$$

and

the cbpc is united with the MB type obtained in the above step b-2) and coded to comply with an mcbpc VLC table of corresponding MPEG-4 I-VOP and P-VOP.

6. The transcoding method of claim 2, wherein the step b-4) performs the conversion according to the following equation,

dquant

$$= \min(\max((mquant \text{ of current MB} - mquant \text{ of previous MB}), -2), 2).$$

7. The transcoding method of claim 2, wherein the step d) comprises the steps of:

estimating a Laplacian distribution of a discrete cosine transform (DCT) coefficient reconstructed from a MPEG-1 bit stream;
determining a reconstruction level using the estimated Laplacian distribution of the DCT coefficient; and
performing quantization according to MPEG-4 using the determined reconstruction level.

8. The transcoding method of claim 2, wherein when an output y with respect to an input DCT coefficient x is expressed by $y = Q_i(x) = \left\lfloor \left[\frac{x}{\Delta} + \frac{1}{2} \right] \cdot \Delta \right\rfloor$, a

quantization step size Δ_i is given by $\Delta_i = \frac{Wi \cdot Q_p}{8}$, $i = 0, 1, 2, \dots, 63$ (Q_p is a

quantization parameter), a decision level t_m is given by $t_m = (m - \frac{1}{2}) \cdot \Delta$, $m \geq 1$,

$x_m = \{x | x \in [t_m, t_{m+1}]\}$ when x belongs to a section $[t_m, t_{m+1}]$, an amplitude level λ_m of x_m

is expressed by $\lambda_m = \left\lfloor \frac{x_m}{\Delta} + \frac{1}{2} \right\rfloor$, an output x' with respect to the input DCT

coefficient y , which has been quantized by a MPEG-1 quantizer having a dead zone in which a reconstruction level for x_m , that is, an inverse-quantized DCT coefficient r_m is given by $r_m = \lfloor \lambda_m \cdot \Delta \rfloor$, is expressed by

$$x' = Q_2(y) = \begin{cases} \left\lfloor \left\lfloor \frac{y}{\Delta'} \right\rfloor \cdot \Delta' + \frac{\Delta'}{2} \right\rfloor & \text{if } Q_p \text{ is odd} \\ \left\lfloor \left\lfloor \frac{y}{\Delta'} \right\rfloor \cdot \Delta' + \frac{\Delta'}{2} \right\rfloor - 1 & \text{if } Q_p \text{ is even} \end{cases}, \text{ a quantization step size } \Delta' \text{ is}$$

given by $\Delta' = 2Q_p$, a decision level t'_n is given by $t'_n = n \cdot \Delta'$, $n \geq 1$,

$y_n = \{y | y \in [t'_n, t'_{n+1}]\}$ when the output y belongs to a section $[t'_n, t'_{n+1}]$, and an amplitude level of y_n , that is, an inverse-quantized DCT coefficient λ'_n is requantized by a MPEG-4 quantizer having a dead zone defined as $\lambda'_n = \left\lfloor \frac{y_n}{\Delta'} \right\rfloor$ and is

converted into a MPEG-4 DCT coefficient, the step d) comprises the steps of:

d-1) defining subscript values allowing the decision level to belong to a section $[t_m, t_{m+1}]$ as a set $P = \{p | t'_p \in [t_m, t_{m+1}]\}$;

d-2) defining candidates of the subscript values of the decision level as a set $K = P \cup \{\min\{P\} - 1\}$ where the symbol \cup indicates a union and an operator $\min\{A\}$ indicates a minimum value among the members of a set A ; and

d-3) selecting a member satisfying a cost function from among the candidate subscript values as a final subscript value, the cost function being expressed by

$$k = \arg \min_{k \in K} |C_m - r'_k| \quad \text{where} \quad C_m = \frac{\int_{t_m}^{t_{m+1}} x \cdot p(x) dx}{\int_{t_m}^{t_{m+1}} p(x) dx}$$

where C_m is an optimum reconstruction level in the section $[t_m, t_{m+1}]$ used by a Lloyd-Max quantizer in view of mean square error, and $p(x)$ is a Laplacian distribution function.

9. The transcoding method of claim 8, wherein in the step d-3), C_m is obtained by analyzing the statistical characteristic of $p(x)$.

10. The transcoding method of claim 9, wherein when it is assumed that AC DCT coefficients comply with a Laplacian distribution expressed by

$$p(x) = \frac{\lambda}{2} \cdot e^{-\lambda|x|},$$

a step of determining the value of λ determining the statistical characteristic of $p(x)$ comprises the steps of:

d-3-1) calculating an average of a random variable $|x|$ according to

$$E(|x|) = \int_{-\infty}^{\infty} |x| \cdot p(x) dx = \int_{-\infty}^{\infty} |x| \cdot \frac{\lambda}{2} \cdot e^{-\lambda|x|} dx = \frac{1}{\lambda}; \text{ and}$$

d-3-2) determining λ according to $\lambda = \frac{1}{E(|x|)}$.

11. The transcoding method of claim 10, wherein the step d-3-2) comprises the steps of:

d-3-2-1) approximating the value of $E(|x|)$ according to

$$E(|x|) \cong E(|y|) + E(|z|)_{\frac{\Delta}{2}}$$

where $E(|z|)_{\frac{\Delta}{2}} = \int_{-\frac{\Delta}{2}}^{\frac{\Delta}{2}} |z| \cdot p(z) dz$, and $p(z) = \frac{\lambda'}{2} \cdot e^{-\lambda'|z|}$ where $\lambda' = \frac{1}{E(|y|)}$;

d-3-2-2) calculating $E(|z|)_{\frac{\Delta}{2}}$ according to

$$E(|z|)_{\frac{\Delta}{2}} = 2 \cdot \int_0^{\frac{\Delta}{2}} z \cdot \frac{\lambda'}{2} \cdot e^{-\lambda'z/2} dz = \frac{1}{\lambda'} - e^{-\lambda'\Delta/2} \left(\frac{1}{\lambda'} + \frac{\Delta}{2} \right); \text{ and}$$

d-3-2-3) estimating the value of λ according to

$$\lambda = \frac{1}{E(|x|)} \cong \frac{1}{E(|y|) + E(|z|)_{\frac{\Delta}{2}}} = \frac{\lambda'}{2 - e^{-\lambda'\Delta/2} (1 + \frac{\Delta}{2} \lambda')}.$$

12. A requantizing method in which an output y with respect to an input

DCT coefficient x is expressed by $y = Q_1(x) = \left\lfloor \left\lfloor \frac{x}{\Delta} + \frac{1}{2} \right\rfloor \cdot \Delta \right\rfloor$, a quantization step size

Δ_i is given by $\Delta_i = \frac{Wi \cdot Q_p}{8}$, $i = 0, 1, 2, \dots, 63$ (Q_p is a quantization parameter), a

decision level t_m is given by $t_m = (m - \frac{1}{2}) \cdot \Delta$, $m \geq 1$, $x_m = \{x | x \in [t_m, t_{m+1}]\}$ when x

belongs to a section $[t_m, t_{m+1}]$, an amplitude level λ_m of x_m is expressed by

$\lambda_m = \left\lfloor \frac{x_m}{\Delta} + \frac{1}{2} \right\rfloor$, an output x' with respect to the input DCT coefficient y , which has

been quantized by a MPEG-1 quantizer having a dead zone in which a reconstruction level for x_m , that is, an inverse-quantized DCT coefficient r_m is given by $r_m = \lfloor \lambda_m \cdot \Delta \rfloor$, is expressed by

$$x' = Q_2(y) = \begin{cases} \left\lfloor \left\lfloor \frac{y}{\Delta'} \right\rfloor \cdot \Delta' + \frac{\Delta'}{2} \right\rfloor & \text{if } Q_p \text{ is odd} \\ \left\lfloor \left\lfloor \frac{y}{\Delta'} \right\rfloor \cdot \Delta' + \frac{\Delta'}{2} \right\rfloor - 1 & \text{if } Q_p \text{ is even} \end{cases}, \text{ a quantization step size } \Delta' \text{ is}$$

given by $\Delta' = 2Q_p$, a decision level t'_n is given by $t'_n = n \cdot \Delta'$, $n \geq 1$,

$y_n = \{y | y \in [t'_n, t'_{n+1}]\}$ when the output y belongs to a section $[t'_n, t'_{n+1}]$, and an

amplitude level of y_n , that is, an inverse-quantized DCT coefficient λ'_n is requantized

by a MPEG-4 quantizer having a dead zone defined as $\lambda'_n = \left\lfloor \frac{y_n}{\Delta'} \right\rfloor$ and is

converted into a MPEG-4 DCT coefficient, the requantizing method comprising the steps of:

d-1) defining subscript values allowing the decision level to belong to a section $[t_m, t_{m+1}]$ as a set $P = \{p | t'_p \in [t_m, t_{m+1}]\}$;

d-2) defining candidates of the subscript values of the decision level as a set $K = P \cup \{\min\{P\} - 1\}$ where the symbol \cup indicates a union and an operator $\min\{A\}$ indicates a minimum value among the members of a set A ; and

d-3) selecting a member satisfying a cost function from among the candidate subscript values as a final subscript value, the cost function being expressed by

$$k = \arg \min_{k \in K} |C_m - r'_k| \quad \text{where} \quad C_m = \frac{\int_{t_m}^{t_{m+1}} x \cdot p(x) dx}{\int_{t_m}^{t_{m+1}} p(x) dx}$$

where C_m is an optimum reconstruction level in the section $[t_m, t_{m+1}]$ used by a Lloyd-Max quantizer in view of mean square error, and $p(x)$ is a Laplacian distribution function.

13. The requantizing method of claim 12, wherein in the step d-3), the balance point C_m is obtained by analyzing the statistical characteristic of $p(x)$.

14. The requantizing method of claim 13, wherein when it is assumed that AC DCT coefficients comply with a Laplacian distribution expressed by

$$p(x) = \frac{\lambda}{2} \cdot e^{-\lambda|x|},$$

a step of determining the value of λ determining the statistical characteristic of $p(x)$ comprises the steps of:

d-3-1) calculating an average of a random variable $|x|$ according to

$$E(|x|) = \int_{-\infty}^{\infty} |x| \cdot p(x) dx = \int_{-\infty}^{\infty} |x| \cdot \frac{\lambda}{2} \cdot e^{-\lambda|x|} dx = \frac{1}{\lambda}; \text{ and}$$

d-3-2) determining λ according to $\lambda = \frac{1}{E(|x|)}$.

15. The transcoding method of claim 14, wherein the step d-3-2) comprises the steps of:

d-3-2-1) approximating the value of $E(|x|)$ according to

$$E(|x|) \cong E(|y|) + E(|z|)_{\frac{\Delta}{2}}$$

where $E(|z|)_{\frac{\Delta}{2}} = \int_{-\frac{\Delta}{2}}^{\frac{\Delta}{2}} |z| \cdot p(z) dz$, and $p(z) = \frac{\lambda'}{2} \cdot e^{-\lambda'|z|}$ where $\lambda' = \frac{1}{E(|y|)}$;

d-3-2-2) calculating $E(|z|)_{\frac{\Delta}{2}}$ according to

$$E(|z|)_{\frac{\Delta}{2}} = 2 \cdot \int_0^{\frac{\Delta}{2}} z \cdot \frac{\lambda'}{2} \cdot e^{-\lambda'z} dz = \frac{1}{\lambda'} - e^{-\lambda'\Delta/2} \left(\frac{1}{\lambda'} + \frac{\Delta}{2} \right); \text{ and}$$

d-3-2-3) estimating the value of λ according to

$$\lambda = \frac{1}{E(|x|)} \cong \frac{1}{E(|y|) + E(|z|)_{\frac{\Delta}{2}}} = \frac{\lambda'}{2 - e^{-\lambda'\Delta/2} (1 + \frac{\Delta}{2} \lambda')}.$$

16. A transcoding apparatus of performing conversion between compressed bitstreams having at least syntax elements and video elements corresponding to video data, the transcoding apparatus comprising:

a decoder for reconstructing syntax elements and video elements from a first bitstream complying with a first compression method;

an inverse quantizer for inverse-quantizing the video elements provided from the decoder according to the first compression method to reconstruct video data;

a quantizer for requantizing the video data according to a second compression method;

a syntax generator for mapping the syntax elements provided from the decoder to syntax elements complying with the second compression method; and

an encoder for encoding the requantized video data (video elements complying with the second compression method) provided from the quantizer and

